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# Fabrication of Games and Learning: A Purposive Game Production

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**Abstract:** The concept of Game based learning has proven to have many possibilities for supporting better learning outcomes, when using educational or commercial games in the classroom. However, there is also a great potential in using game development as a motivator in several other kinds of learning scenarios. Using game development as an approach for including game based learning in various educations has become more accessible due to more user friendly game development tools and systems. This study will thus focus on an exploration on how game development motivates students and what they learn when creating games. We exemplify the potential of using game fabrication as a learning environment with the investigation of a game production, which involved over 25 students across semesters. In order to investigate students' experiences during this purposive game production, we set up an experiment where students were "hired" to work in a virtual game development company. Students then had to produce a game concerning global warming during their 2.5 months semester project. The main results indicated that students who worked on the purposive game production acquired several new technical and analytical skills, they increased their skills in production management, and they were more motivated to continue their studies after the production. The findings illustrate that there are great potentials in harnessing the power of game development in education. We conclude with a framework of best practice guidelines for other educators, who want to incorporate a purposive game production in their own activities.

**Keywords:** game based learning, game development, purposive game, problem based learning, production-oriented learning

## 1. Introduction

Using games as learning tools have been studied for several years, and the learning outcomes are often reported to be rather successful (Wang, 2010; Yang, 2012). Digital Game-Based Learning has furthermore shown the highest growth within higher education (Hwang, 2012). The motivational factor of using games has been proved to be a major part of the success, but at the same time the lack of student's motivation is still a big problem within university educations (Armstrong et al, 2013). We find that a major challenge would be to establish a teaching and learning environment which could use features from Digital Game-Based Learning and at the same time focus more on the motivational factors. One of our main questions is: how could a learning environment be established - based on Digital Game-Based Learning - promote the integration of learning specific topics, keep students' motivation and interests and at the same time be part of an existing curriculum? We see learning at its best when it is active, goal oriented, contextualized and interesting, and the teaching/learning environment should be interactive, provide ongoing feedback, sustain attention and have appropriate levels of challenge (Woo, 2014). This learning approach is reflected in Problem Based Learning (PBL) and project organized teamwork (Barge, 2010). Aalborg University applies PBL pedagogy in all its programs, which supports students' learning processes and an important feature of this model is that the motivational aspects is one of the basic elements. However, we have experienced that even when using the PBL model, students may lack motivation (Reng and Kofoed, 2012). Furthermore, we have found that students at Media Technology were very motivated, when they were developing or playing games (Reng and Schoenau-Fog, 2010). Therefore we decided to introduce a learning/teaching environment that would enhance students' motivation and at the same time give students the competences required in the study regulation (SICT, 2014). All technical programs at Aalborg University are based on PBL where each semester is divided between courses (15 ECTS) and problem based project work (15 ECTS). This is also the case for Media Technology where 100+ students study at each semester. At the later semesters, many students begin to consider if their competences are good enough to work in a company and we have the experience that a lot of students would like to work within the game industry after graduation. Therefore, designing a new learning/teaching environment closer to "the real world" led to rethinking the project work for the Media Technology fifth semester students. To meet these challenges a few teachers came up with a new concept for a game-based learning project, which was to let students develop a game in a virtual game company as a real production team.

In this paper we describe in detail the pedagogical ideas of the learning/teaching environment and the planning of a pilot project. Furthermore, we will describe the production process as well as the students learning and motivational process while producing the game. We then describe and analyse these learning outcomes and motivational intents during the project process, and conclude with a best practice framework to be used, when planning game-based-learning inspired problem-based, production-oriented project work.

## 2. Background

This study is founded on various pedagogical approaches and game based learning theories. In this chapter we will describe these further.

### 2.1 Pedagogical approach

In order to heighten students' motivation during their problem based project work as well as to provide the students with new knowledge and competences within game-production and project management, this paper contributes with a design-based learning approach founded on a production oriented game development when creating educational computer games. Previous projects on learning by design have especially provided successful results within technical and science areas (Ke, 2013). According to theories of problem-based learning and situated learning, design creates contextualized and authentic learning as design tasks force students to work in an environment which demands close to real life skills and domain knowledge when doing projects work. Developing knowledge and skills required in such situations are in addition more transferable to future situations (De Vries, 2006). Design-based learning using 'enactivism' which is a framework that argues for a close connection between affordance of a learning environment and a learner's capacity of action and perception in knowledge development (Lo, 2012) seems to fit to our pedagogical approach. Digital game development has been considered and examined as a "powerful learning environment" to stimulate active, autonomous learning via rich contexts and authentic tasks of composition and construction (Robertson, 2008). Educational game making, that requires content application, can be applied as a "micro-world" where designers or learners get to explore, represent and test their domain knowledge and skills and to integrate them into the game designed (Mitchell and Saundry, 2007). We find that design based learning in general and computer game development in particular is well connected with PBL and project work which will be the pedagogical approach for this case at 5th semester Media Technology. This approach has potential for using game fabrication as a motivational factor, while students gain knowledge from all aspects of game production. (See fig 1).

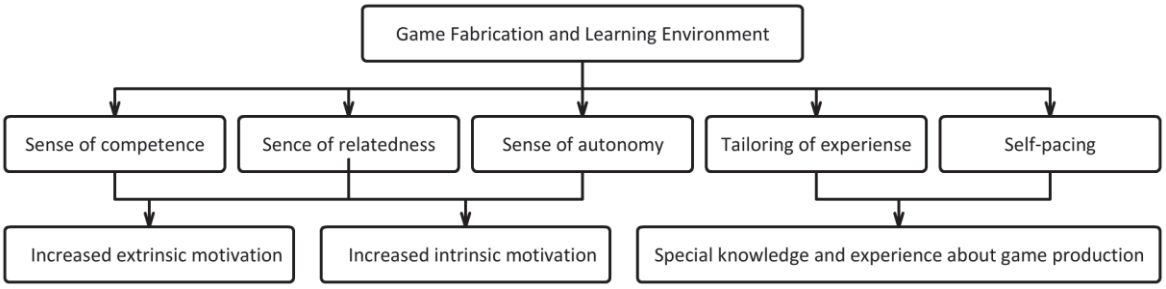


**Figure 1:** The pedagogical elements in the fabrication of games and learning production environment (inspired by Abeysekera and Dawson 2015)

### 2.2 The purposive game production – an experiment

The authors of this paper have in recent years greatly increased collaboration with both neighbouring universities and industry, in an effort to improve the quality of the Media Technology education. Through a close partnership with many national and international media companies we have learned about the composition and procedures of many of these companies' successful development teams. The idea behind the purposive game production was mainly motivated by the following three major issues: Students reaching the end of their bachelor education seem to have a growing concern about the transition from the skills and abilities they have learned during the education and the needs and requirements of the industry. It was clear that one of the most burning questions from the students to every invited speaker with an industry background was: "What do you expect from us when we apply for our first job, and do you think we have the qualification required by your company?" Another major issue was that the students did not feel that they ever had enough time to focus on a single skill/discipline in order to truly understand what is required to fully master it. Students were furthermore not easily convinced that our candidate educations do offer this depth while still holding a strong academic focus

even though several successful student projects on both bachelor and master level have resulted in published peer-reviewed papers that were presented at international conferences in recent years.

In order to create a format that would allow both for full control of the production to the teacher, giving the students an experience as close as possible of to that of being in a company, and still staying within the requirements and rules of the current study plan - and a very limited time frame - we settled on the format described below (Fig 3). The students would have their semester split in two. First a three month period, in which the students would be part of the virtual company in the purposive game production. Second a one month academic project, where the students would be split in smaller 4-6 person project-group size, and use their product of the game production to develop and investigate an academic problem within the theme of their semester. Out of the approximately 100 students on the fifth semester we only needed 20 for the experiment. Each of the 20 roles for the production was carefully decided upon based on industry practice, the students' lack of experience, and the short timeframe of the production. Most of the European developing teams we interviewed are using some form of agile method, such as SCRUM, to manage and control their development. Therefore we quickly decided to use this structure (Schwaber, 2004). Most SCRUM models function with a project owner role being part of the company, but not part of the development team. The project owner is placed between the developing team and the customer and is setting up the requirements for the product. By giving ourselves these roles, we would have a full control over the production, but none of the daily management tasks which should be done by the students. It was very early agreed on that we should not select students based on skill level or previous grades. Instead we would allow all students to apply for the positions they felt most passionate about. Before the students went on their summer holiday, we informed them that they would receive an email with a job offer for our new virtual game development company. A few weeks later, we distributed an email where the students could apply for one of the positions in the game development team. The number of students, that both replied with a portfolio and accepted the contract where they promised to work fulltime, including following every lecture and course assignment, was exactly 20, and the distribution of roles was also almost exactly as desired, so every student could get their profession of choice.

A few weeks before the end of the summer holiday we started to receive a series of unusual emails. The students were asking if they could please be informed about the requirements of the purposive game production, because they wanted to skip the last weeks of their holiday, if we allowed them to start early. Based on the fact that they had to do a project more than the other students on the same semester, we agreed to give them a kick-off meeting 10 days before the official semester start.

The most important requirements for the game was:

- The game must be a meaningful, purposive game, build with the purpose to enhance teaching of a real, critical, and important topic in public schools (kids age 13-16).
- The game had to be 100% factual valid, and true to the latest research in the field.
- The game must give the young people an experience that would facilitate a fact-based discussion about the topic and its possible solutions in the classroom.
- The game had to meet a professional quality that would allow the students to use it when applying for a future job.
- The game had to be of a quality and integrity that would allow it to be used in our game-researchers' future work.

Directly caused by the short timeframe, we had to give the students a simplified timetable with only a few of the traditional phases of a game production. Since we knew the students were in unfamiliar waters in so many aspects compared to their traditional semester projects, it was decided to keep a fairly high amount of regularly spaced deadlines to ensure that mismanaged activities were detected early. (See figure 3).

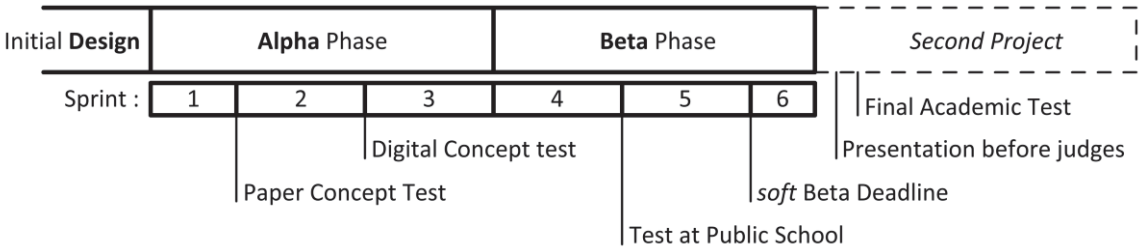


**Figure 3:** The purposive game production time table

To give another incentive to perform their best and meet the final deadline of the production, we called in a group of seven game company CEOs to judge the quality of the final product. Even though the quality of the finished production was not nearly as high as required for a professional production, several of the students were offered jobs by these companies in the weeks following the final product presentation.

The participants in the production were mainly students on the 5th semester at the Media Technology education at Aalborg University, Copenhagen. Furthermore, a few students from the Media Technology master education also joined the project. The production facilities were organized in a large project-group room at Aalborg University's campus in Copenhagen where the purposive game production team members organized their own area and divided it into sections based on their roles – for example programmers, 3D designers, 2D designers and production management. The game development tools which were used to develop the game were Unity 3D, a suite of Autodesk animation tools and various open source programs. The roles of the students in the team were as follows: Producer/production manager, production advisor, creative director, lead programmer, assistant programmer, lead designer, assistant designer, lead sound designer, assistant sound designer, 2D art lead, 2D artist, writer, lead game designer, game designer, 3D art lead, 3D artist, 3D modeller, 3D animator, creative designer.

The results of fabricating the game can for example be seen in a video, which describes the overall concept of the game (The Purposive Game Production, 2014).

## 3. Methods

We used an exploratory case-study approach (Stebbins, 2001) in combination with the descriptive, mixed-method case study (Stake, 1995; Yin, 2008) to investigate the students' experiences.

This examination explored the process of learning by design within the context of digital game development, project management and production. In particular this study addressed the following research questions:

- Did participating in a production of game development enhance motivation towards further studies and learning in general and in particular within Media Technology?
- How did the different aspects of the process of game production give knowledge and understanding of the various game development tasks?

### 3.1 Data collection

In order to acquire data from the production, we conducted a number of supervision meetings with the students during the semester, where we inquired them about their experiences. Furthermore, we distributed a survey to students at the end of the production phase where we asked them about their motivation level, before, during and after the production; learning outcomes and other questions related to their experiences. In order to verify the results of the survey, we conducted an interview with the whole team of students at the end of the production period.

## 4. Results

In the following, the results from the survey, observations and interviews will be presented.

### 4.1 Survey results

25 students participated in the survey. Four were female and 21 were male.

### *4.1.1 Motivation*

The survey included a series of questions where the students were asked to rate their motivation or learning outcome compared to previous semesters (0 = Much less/None, 5 = Same, 10 = Much more/Very high).

It was clear that the students' anticipation was very high at the beginning of the project. This was expected for a new hyped production oriented style of project work. The challenge was to see if the students could keep their motivation throughout the project period. More importantly, we were curious to see if the new format would increase the students' motivation towards their next project and the education as a whole. The survey included a number of quantitative questions to support this investigation:

> *(Q1): "How high would you rate your motivation at the beginning of the project?" (AVG=8.64, STD=1.44)*
>
> *(Q2): "How high would you rate your motivation at the end of the ALPHA-phase of project?" (AVG=6.92, STD=1.85)*
>
> *(Q3): "How high would you rate your motivation right now? (End of Beta)" (AVG=5.44, STD=2.48)*
>
> *(Q4): "What is the possibility that you would join a production semester project in the future?" (AVG=8.36, STD=1.70)*

From the interviews it was clear that many of the students had worked harder than on any other projects before this. The SCRUM system with task lists, internal self-monitoring, and weekly presentation of work-effort graphs for all made it impossible to 'free-ride' unnoticed. With the new enlarged team size, communication and management became a much bigger issue. From both the weekly status presentations to the project owners and the interviews, the students clearly stated that they were surprised and somewhat demotivated by the effort it requires managing such a large team. The change in motivation through the phases of the project also clearly depicts the fatigue towards the end, as shown in figure 4 (Q1-Q3). However, when students were asked about their motivation to join another similar project in the future they were almost as motivated as in the beginning of the project. Even though they were asked when most fatigued (at the end of the production).

As stated earlier, one of the main goals of the format was to investigate that if students were introduced to the flexibilities and production oriented possibilities of the PBL based semester projects, it would increase their desire to continue studying and signup for one of the candidate studies. Questions (Q7 + Q8) in combination with the interview aims to clarify this point. As shown in figure 4, there is a clear indication that the motivation to continue the study indeed increased from Q7 to Q8. The standard deviations do however prevent us from claiming any statistical significant change in motivation.

> *(Q7): "How high would you rate your motivation to continue studying at Medialogy at the end of last semester?" (AVG=6.48, STD=1.92)*
>
> *(Q8): "How high would you rate your motivation to continue studying at Medialogy right now?"(AVG=7.92, STD=1.71)*

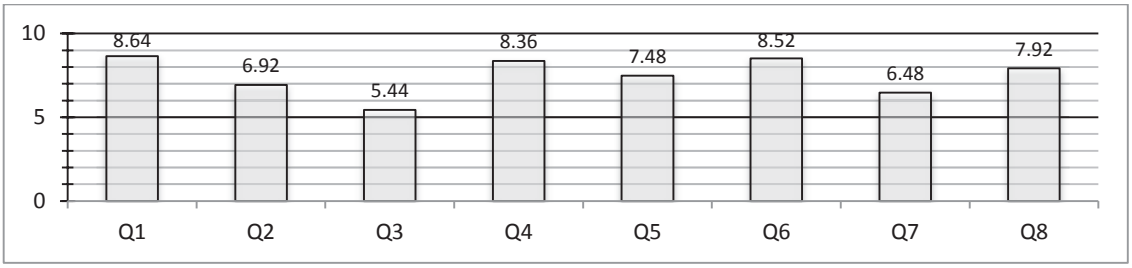


**Figure 4:** Study motivation and learning outcome. Questions Q1-Q8 described in the text.

### *4.1.2 Learning and skills*

One of the clear benefits of a production oriented project format with clear roles is that it allows the students to get a much deeper focus on a single craft/skillset. Naturally there is also the negative effect that the students do not get any practice in the areas they did not select. We specifically selected the fifth semester for this experiment since it is so close to the candidate studies where students should select a discipline to focus on and master before applying for their first job.

*(Q9): "How would you range your skills in [your own] role before the project launch (0-10)?" (AVG=4.44, STD=2.16)*

*(Q10): "How would you range your skills in that role [at the end of the production) (0-10)?" (AVG=7.21, STD=1.24)*

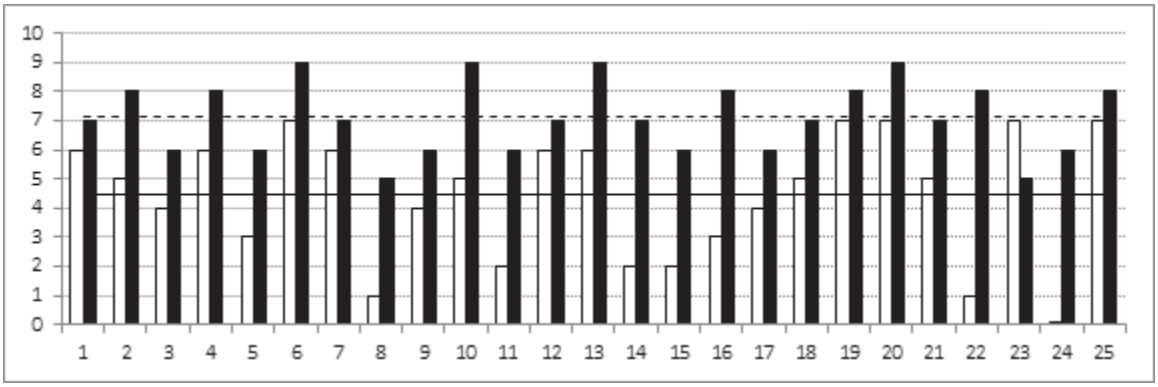


**Figure 5:** Learning and skills. Q9: Skills before (white bars). Q10: Skills after (black bars). Respondents 1-25.

When questioned on their perceived skill level before and after the production, the students in average rated that they had increased their skills in the chosen role by 60% (see Figure 5). Even when directly comparing the increased skill level to the increase of earlier semesters, there is a clear tendency that the students feel that they have increased their skills/crafts significantly with the new format (Q5).

*(Q5): "How much do you feel you have improved your skills/crafts in this project, compared to earlier semester projects?" (AVG=7.48, STD=2.10)*

During the supervision it became clear that the increased team size forced the students to abandon their usual simple managing technique, and search for a more stable and professional solution. The learning outcome in this area showed to be much higher than expected during the planning of this format, see Figure 4 and question (Q8). The new production format clearly gives the students a significantly higher perceived learning outcome than the traditional smaller PBL based semester projects.

*(Q8): "How much do you feel you have learned about the challenges of managing a large production group in this project, compared to earlier projects?" (0=Much less, 5=Same, 10=Much more) (AVG=8.52, STD=1.33)*

## 4.2 Focus groups results

25 students participated in the focus-group discussion, which was led by the authors. Four of the participants were female and 21 were male. The focus-group interview was semi-structured based on the interest we had to verify the survey results and to get more detailed answers on the reasons for students' responses. When the participants were asked to state one word, which summarized their experience they discussed among themselves and replied with the following words: A good learning experience, Hectic (in a positive way), Hard, Confusing/chaotic, Frustrating, Awesome, Fun and "a different, good concept". In the following the statements used when describing the choice of words will be presented in detail:

*A good learning experience:* Students stated that they learned a lot from the project. Especially new tools, skills, communication, production management, resource management, how to work in a company, about defining a target group, SCRUM, to use each other, the freedom to learn and do everything by themselves.

Everybody stated that they were motivated to work on a production like the purposive game production again. Half of the students stated that they learned more than in other semesters.

*Hectic:* Students stated that they had too high ambitions with the game, as their skills were not at the same level. The deadlines were not communicated clearly and there were many communication problems between the different sub-teams while the production lacked structure due to challenges with the management. Students used a lot of "all-nighters" on the project, where they kept working through the night. The leads also stated that having the task to lead the team is very time consuming. Finally, they also mentioned that they learned to listen to each other and to solve problems.

*Hard:* "Tough but good". Students had some challenges in understanding what the different roles were responsible for. It was hard to learn to be a lead and the role had a large responsibility, as stated in this response: "To give and to take responsibility". On the other hand assistants often did not have an overview of what to do. Leads often had to take over and it was also hard for them, when they should make sure that their study-colleagues worked hard enough. It was not possible to delimit the ambitions before it was too late. It was too much responsibility to be a lead and a scrum-master at the same time. It was also hard to follow the semester courses at the same time as the production.

*Confusing:* The organization of the production could be better, some students felt it was a chaotic production and they experienced "management hell". The structure was not set up from the start and SCRUM should be learned before the production. There were also communication problems in the beginning of the production and there were too many tasks at the same time. It was hard to take design decisions in the beginning and the production pipeline did not work in the start and people changed roles during the production. 25+ members of the production team were also too many, students reported.

*Frustration:* For most students it was frustrating that the final game did not end up as they wanted due to the high ambition with the game, and the low technical skill level of many team members, in the students' words: "The bar was too high". In the programming team, 4 were experienced programmers, while 4 were new to programming which made a too big difference

*Awesome, fun and a different, good concept:* Students stated that it was a good initiative due to the possibility to work with other semesters (the master students). They gained a more personal relation to other students on other semesters and got new friends from other interest groups, because within the large group, smaller teams formed based on their roles in the production. It was good to learn to work together. Students also felt they networked more and had a common goal to make something bigger, to finish something. While learning from other students, team members gained a lot of experience, which they thought would be valuable for them in the future. Students stated that they liked to have a lot of ownership of the production and that it was good that they were in charge themselves.

## 5. Conclusion

It can be concluded that the group-organised production-oriented problem-based project-work does have the flexibility and framework for establishing a learning/teaching environment which could enhance students' motivation for further studies and at the same time gain knowledge and experience within aspects of game production and management of larger productions. This approach supports students different interests within the different semesters study-regulations as well as it can give experiences very close to a real production situation.

The main findings of the survey, observations and interviews are that students learned a lot, and that the game-development based learning strategy seems rather efficient and demanding for the students. Their motivation to continue working on the production fell during the process, but increased towards the end. However they still wanted to work on another similar production and their motivations to continue their studies were higher at the end of the production. Students also experienced a lot of frustration due to the overwhelming challenge of managing a team of 25+ team-members, causing them to truly understand the importance of good project management. The students experienced that sufficient communication as well as planning and coordination of the game production as a whole as well as the team's collaborative production is very important, and that they had to be better equipped regarding those aspects. These reflections might be the best starting point for new learning processes – which furthermore was emphasized by the fact, that members of the jury committee offered jobs to the students. To the claim that it requires an extensive amount of knowledge to build a knowledge mediating purposive game, we witnessed that the students on their own initiative found it necessary to build their own wiki in order to structure their large amount of gathered research about climate change.

In summary we can conclude that the new learning environment together with the elements in our pedagogical model have given students increased motivation to continue their study as well as special knowledge and experience about game production.

The findings from the supervision, survey and interviews may now be used to summarize ideas on how future purposive productions can be organized better.

### 5.1 Best practise framework

The following best-practice framework is a summary of the experiences from the production, which may be used as inspiration for similar problem-based and production-oriented project-work ($P^3$) founded on design and game-based-learning.

- Maximum 15 persons per group, during the students first experience with $P^3$.
- Introduction course to production management tools and SCRUM, so that the team know what it is, before the production starts.
- The design should be decided on and fixed at an early stage.
- Roles and responsibilities should be clear.
- Students should be able to choose their own teams based on portfolios and early discussions.
- A good management tool is essential.
- Make sure all team-members maintain a high level of communication with other teams.
- Develop ideas across the different roles in the production.
- The Leads should have the power to decide (democracy is not always the solution).
- Project owners (supervisors) may help a lot by supervising closely and by setting clear goals, requirements and demands. It is essential that they make sure to give feedback often.
- Latest versions of the game ("builds") should be available all the time
- It is beneficial to work cross-semester, as the more experienced students can help and at the same time learn a lot.
- The group should meticulously evaluate each members skills before setting their ambitions.

In conclusion, the purposive game production experiment indicates that there is a lot of potential in using game fabrication and problem-based and production-oriented project-work as a learning environment. We will in future work focus more on improving the context of the productions in order to make it even more beneficial for students.

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